Astronomy 345: Principles of Astronomy / High Energy Astrophysics

Fall 2019 (3 credits) TuTh 9:10-10:25am Webster 11
Prerequisites:

Instructor: Dr. Matthew Duez

Office Location: Webster 947E
Phone: (509) 335-2396
Email: m.duez@wsu.edu
Office hours: Monday 3-4:30pm

Textbooks

Required: *An Introduction to Modern Astrophysics* by Carroll and Ostlie

Student Learning Outcomes

The goal of this class is to teach students the concepts of astrophysics and astrophysical problem solving through a study of high-energy astrophysics and cosmology. Examples of "high-energy" sources we will study are accreting black holes, supernovae, and compact binary systems. Common features of these sources are that they are dynamical (meaning they flash or at least flicker rather than having a constant glow), strong-gravity (involving white dwarfs, neutron stars, or black holes), and emit electromagnetic radiation across a wide range of wavelengths (radio waves, visible light, X-rays, etc.). The class will be mainly theoretical, but as often as possible I want to expose you to real data and get you involved in the reasoning that connects data and its theoretical explanation. This will require you to learn about the wide variety of states of matter in outer space, how they radiate, and how they flow, at a level appropriate to a mid-level undergraduate physics major.

So, by the end of the class, you should

- have a basic knowledge of standard model cosmology
- know the basic features of a variety of high-energy astrophysical phenomenon
- have a good qualitative grasp of ideas in gas dynamics and radiative processes. (E.g. when should one expect local thermodynamic equilibrium? When should one expect thermal radiation? What causes synchrotron radiation?)
- be able to reason from the general properties of a high-energy astrophysical event to characteristics of its source

Grade Breakdown

Homeworks:	50%
Student presentations:	20%
Exam 1:	15%
Exam 2:	15%

Homework and student presentations

There will be 10 homework assignments, roughly one per week. Homework will help guide lectures, so we will spend some time in class discussing assignments before they are due. On the day homework is due, students must turn in assignments when they come in. Then a group of two students will present the solutions to the class. It is strongly recommended that the presenting students come to my office sometime before lecture (my office hour that week or by appointment) to check their work with me. Homework solution presentations are a non-negligible component of students' grades, as indicated above. After the presentation, attending students will be allowed to write a supplemental page to their homework listing things they think should be corrected in their original assignment. Depending on the quality of the supplement, students may recover up to 50% of the points they would have missed on the original assignment.

Because of this arrangement, it will be very difficult for me to accept late assignments. If you must miss a lecture when homework is due, turn in your assignment early. If some extreme unexpected situation arises and this is not possible, please email me and explain as quickly as possible.

Exams

There will be two tests which will be a combination of short essays and order of magnitude problem solving. Prior to each test, I will provide a list of practice questions, and your actual test will consist of variations on some subset of these.

Grade distribution

Below is a rough guide to how numerical grades will correspond to letter grades. I won't push the cutoffs up, but may push them a little bit down.

A	88-100%
B	75-87
C	63-74
D	50-62
F	< 50

Academic Integrity

Students may discuss and work together on assignments, but all submitted work must be original and individual. Academic dishonesty, including all forms of cheating, plagiarism, and fabrication, is prohibited as stated in the WSU Handbook. (See http://conduct.wsu.edu/.)

WSU Disability Statement

Reasonable accommodations are available for students with a documented disability. Please notify me the first week of class of any accommodations needed. Late notifications may cause requested accommodations to be unavailable. All accommodations must be approved through Disability Resource Center (DRC), Administration Annex 205, 335-1566.

WSU Safety

For WSU's general safety statements, see http://safetyplan.wsu.edu.
For current safety alerts, see http://alert.wsu.edu.
For advice on dealing with emergencies, see http://oem.wsu.edu/emergencies.

Course Outline

Material:	measures of brightness, blackbody radiation, cosmological observations
Homework 0:	the cosmic microwave background
Material:	spacetime causal structure and curvature, the expanding universe
Homework 1:	horizons, black hole and cosmological
Material:	spectral lines, mean free paths, electron scattering
Homework 2:	the sun
Material:	nonthermal emission, esp. synchrotron radiation, variability
Homework 3:	the Crab nebula and pulsar
Material:	orbital mechanics, gravitational waves
Homework 4:	binary black hole merger GW150914
Exam 1	
Material:	Roche lobe overflow, random walk
Homework 5:	binary neutron star merger GW170817
Material:	equilibrium thin disk accretion
Homework 6:	black hole candidate Cygnus X-I
Material:	Blandford-Znajek effect, advection-dominated accretion flows
Homework 7:	Sagittarius A*
Material:	stellar equilibria, polytropes
Homework 8:	main sequence mass-luminosity relation
Material:	degenerate objects, supernova afterglows
Homework 9:	supernovae light curves
Material:	core collapse, gamma ray bursts
Exam 2	